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secretion is evident; since no pus was ever observed in the urine either before, or after the introduction of the catheter. How this extraordinary case comes to be so particularly circumstanced seems worthy of consideration. If the singularity of it shall merit any regard from your Lordship, and the gentlemen of the Society, it will give the highest satisfaction to,

my Lord,

Your Lordship's

All Souls College,  
Nov. 24th, 1762.

most obedient and

most humble servant,

Daniel Lyfons.

CIII. *Experiments to prove that Water is not incompressible; by John Canton, M. A. and F. R. S.*

Read Dec. 16,  
1762.

HAVING procured a small glass tube of about two feet in length, with a ball at one end of it of an inch and a quarter in diameter; I filled the ball and part of the tube with mercury; and keeping it with a Fahrenheit's Thermometer, in water which was frequently stirred, it was brought exactly to the heat of 50 degrees; and the place where the mercury stood in the tube, which was about  $6\frac{1}{4}$  inches above the ball, was carefully

fully marked. I then raised the Mercury, by heat, to the top of the tube, and sealed the tube hermetically; and when the mercury was brought to the same degree of heat as before, it stood in the tube  $\frac{3}{100}$  of an inch higher than the mark.

The same ball, and part of the tube being filled with water exhausted of air, instead of the mercury; and the place where the Water stood in the tube when it came to rest in the heat of 50 degrees, being marked, which was about 6 inches above the ball; the water was then raised by heat till it filled the tube; which being sealed again, and the water brought to the heat of 50 degrees as before, it stood in the tube  $\frac{4}{100}$  of an inch above the mark.

Now the weight of the atmosphere (or about 73 pounds avoirdupois) pressing on the outside of the ball and not on the inside, will squeeze it into less compass. \* And by this compression of the ball, the mercury and the water will be equally raised in the tube: but the water is found, by the experiments above related, to rise  $\frac{1}{100}$  of an inch more than the mercury; and therefore the water must expand, so much, more than the mercury, by removing the weight of the atmosphere.

In order to determine how much water is compressed by this, or a greater weight, I took a glass ball of about an inch and  $\frac{6}{100}$  in diameter which was joined to a cylindrical tube of 4 inches and  $\frac{2}{100}$  in length, and in diameter about  $\frac{1}{100}$  of an inch; and

\* See an account of experiments made with glass balls by Mr. Hooke, (afterwards Doctor Hooke,) in Doctor Birch's history of the Royal Society, Vol. 1. page 127.

by weighing the quantity of mercury that exactly filled the ball, and also the quantity that filled the whole length of the tube; I found that the mercury in  $\frac{2.3}{1000}$  of an inch of the tube, was the 100000th part of that contained in the ball; and with the edge of a file, I divided the tube accordingly.

This being done, I filled the ball and part of the tube with water exhausted of air; and left the tube open, that the ball, whether in rarefied or condensed air, might always be equally pressed within and without, and therefore not altered in its dimensions. Now by placing this ball and tube under the receiver of an air-pump, I could see the degree of expansion of the water, answering to any degree of rarefaction of the air; and by putting it into a glass receiver of a condensing engine, I could see the degree of compression of the water, answering to any degree of condensation of the air. But great care must be taken in making these experiments, that the heat of the glass ball be not altered, either by the coming on of moisture, or it's going off by evaporation; which may easily be prevented by keeping the ball under water, or by using oil only, in working the pump and condenser.

In this manner, I have found by repeated trials, when the heat of the air has been about 50 degrees, and the mercury at a mean height in the Barometer, that the water will expand and rise in the tube, by removing the weight of the atmosphere, 4 divisions and  $\frac{6}{10}$ ; or one part in 21740; and will be as much compressed under the weight of an additional atmosphere. Therefore the compression of water by twice  
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the weight of the atmosphere, is one part in 10870 of it's whole bulk.\*

The famous Florentine experiment, which so many Philosophical writers have mentioned as a proof of the incompressibility of water, will not, when carefully considered, appear sufficient for that purpose: for in forcing any part of the water contained in a hollow globe of gold through its pores by pressure, the figure of the gold must be altered; and consequently, the internal space containing the water, diminished; but it was impossible for the gentlemen of the academy *del Cimento* to determine, that the water which was forced into the pores and through the gold, was exactly equal to the diminution of the internal space by the pressure.

\* If the compressibility of the water was owing to *any air* that it might still be supposed to contain, it is evident that *more air* must make it *more compressible*; I therefore let into the ball a bubble of air that measured near  $\frac{6}{100}$  of an inch in diameter, which the water absorbed in about four days; but I found upon trial that the water was not more compressed, by twice the weight of the atmosphere, than before.

The compression of the glass in this experiment, by the equal and contrary forces acting within and without the ball, is not sensible: for the compression of water in two balls, appears to be exactly the same, when the glass of one is more than twice the thickness of the glass of the other. And the weight of an atmosphere, which I found would compress mercury in one of these balls but  $\frac{1}{3}$  part of a division of the tube, compresses water in the same ball 4 divisions and  $\frac{6}{10}$ .